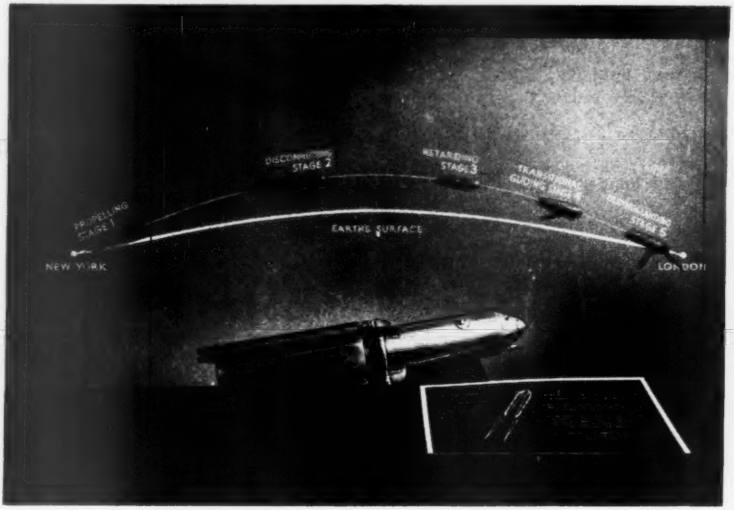
ASTRONAUTICS

JOURNAL OF THE AMERICAN ROCKET SOCIETY

50 CHURCH STREET, NEW YORK CITY

Number 43 August, 1939



A.R.S. Experimental Rocket No. 3 on display in the "Rocketport of Tomorrow". Chrysler Building, New York World's Fair.

The exhibition of one of the Societies test models at the Chrysler demonstration of Rocketship transportation of the future does much to lend reality to a program considered by some to border on the fantastic. This display offers convincing proof that serious minded scientific work is being conducted today to learn more of the principles of jet propulsion. See page 16 for a description of this display.

The placard to the right of the model shows a simple diagrammatic layout of the rocket mechanism, and the printed matter reads as follows:

American Rocket Society
Experimental Liquid Fuel Rocket No. 3

Built and tested as a part of a definite program of Research in the pioneering field.

The principle of the Rocket, jet propulsion, is the only method known which can bring alone the realization of man's age old dream--the conquest of space.

Loaned by the American Rocket Society
50 Church St.
New York City.

ASTRONAUTICS, official publication of the American Rocket Society, is devoted to the scientific and engineering development of the rocket and its application to problems of research and technology. Published by the American Rocket Society, 50 Church St., New York City. Subscriptions with associate membership, $3 per year. Edited by Roy Healy and James R. Glazebrook.

NOTES AND NEWS:

At a recent meeting of the Board of Directors of the American Rocket Society the following members were elected for the fiscal year 1939:

Alfred Africano
James R. Glazebrook
Roy W. Healy
Max Krauss
Dr. Samuel Lichtenstein
H. Franklin Pierce
John Shesta

The following officers and officials of the Society were elected:

Alfred Africano, President
H. Franklin Pierce, Vice-President
Max Krauss, Secretary
Dr. Samuel Lichtenstein, Treasurer

EDITORS OF ASTRONAUTICS
Roy W. Healy
James R. Glazebrook

G. Edward Pendray, Chairman of Advisory Board

John Shesta, Chairman of Experimental Committee

James R. Glazebrook, Chairman of Public Relations Committee

CONTENTS

THE NEW EXPERIMENTAL PROGRAM

Entering upon its 10th year of activity the American Rocket Society looks backward on its work with a feeling of mingled pride and regret. Pride for its outstanding accomplishment of putting rocket research on a sound engineering basis by means of proving stand recordings of actual performance figures on thrust, duration, chamber pressures, feed pressures, fuel consumption and other essential data, formerly only roughly estimated or guessed at, and the deriving of empirical formulas from these figures. Regret -- for the limitations imposed on experimental work by insufficient funds.

Reflecting the enthusiastic spirit of the Society as a whole, the Board of Directors, at a meeting on May 4, authorized the undertaking of a new experimental program, work on which is already underway. During the coming year we hope to see:-

AMONG NEW MOTORS TESTED

(1) Alfred Africano's long awaited REP-Hirsch Prize-winning motor....refractory lined, with interchangeable water-cooled nozzles having throats from $\frac{1}{2}$" to 1" in diameter.

(2) The Westchester Rocket Society design ...... brass, regenerative and water cooled, with diverging combustion chamber.

(3) Roy Healy's aircraft takeoff assisting motor...Venturi air-cooled, thrust augmented, with 1" nozzle throat.

(4) H. F. Pierce's new adaptations of the original A.R.S. design.

A LIQUID FUEL ROCKET SHOT

All members desiring to attend the flight test of a new liquid fuel rocket, now under construction by John Shesta, Chairman of the Experimental Committee, are instructed to communicate with the Secretary. Details of the new rocket will be published at a later date.

CONTINUATION OF THE PAWLING TESTS

A score of dry fuel models are now being built with which to continue the attack on the stability problem, work out parachute release methods, and train observers in using the new Pierce Rocket Range Finder.

EXPERIMENTS WITH POWDER MOTORS
FOR ROCKET PROPULSION BY SUCCESSIVE IMPULSES

by
John W. Parsons and Edward S. Forman
Pasadena, California

(While the American Rocket Society believes the liquid fuel rocket motor has very definitely proven its superiority over powder motors, rocket research is still in too infantile a state to eliminate, with a wave of the hand, any possibility. Thus it is with pleasure we herewith present the first results of what is without doubt the most painstaking investigation into dry fuel motors since early Goddard days. Ed.)

A research into powder rocket motors, based on previous information, has been made in the past several years by the authors. Various types of motors have been constructed and studied, and the results arranged for analysis.

In considering the two systems of powder rockets, that is, the slow-burning rocket as applied in pyrotechnics, life-saving, and the Congrieve, Tilling and Damblanc motors, and the fast-burning type described by Goddard [(1)] it may be seen that higher efficiencies have been obtained with the latter. In addition, we found that the slow-burning rockets gave erratic results, and were uncontrollable and liable to explode.

The experiments of R. H. Goddard in 1919 show that, although the heat energy of the powders used is relatively low,

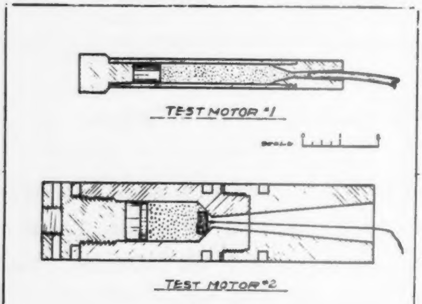


Fig 1

Diagrams of Motors used in tests

(1) A Method of Reaching Extreme Altitudes, R. H. Goddard. Smithsonian Miscellaneous Collection. Vol. 72, No. 1

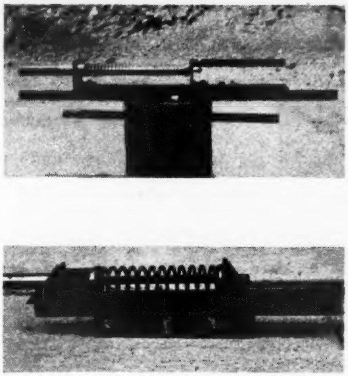


Fig. 3. Large Test Stand (No.2)

the thermal efficiencies obtainable are high. In these experiments exhaust velocities of almost 8000 ft. sec. were recorded.

Furthermore, Goddard's performance analysis may be substantiated in showing the theoretical possibility of such rockets reaching extreme altitudes[2]. It was, therefore, concluded that further research in the field of the fast-burning, constant volume powder motor was well worthwhile.

Although constant pressure motors have been fired over time intervals, data on constant volume motors has been given only for single shots. It may be that serious reloading mechanism difficulties stand in the way of powder rocket development. Since excessive combustion chamber weight must be avoided by the successive injection of small charges, the design of a successful reloading mechanism is essential to the performance of the powder rocket. Before such design was undertaken, however, it appeared that the following major problems required more detailed study:

1. The effective exhaust velocity and thermal efficiency of the powder rocket obtainable with various powders.
2. The effect of chamber pressure on the thermal efficiency.
3. Methods of varying the chamber pressure.
4. Chamber and nozzle design.
5. The effect of the method of ignition and the physical state of the powder.

EXPERIMENTAL APPARATUS

Two motors, shown in Fig. 1, were used in the experiments; one small, having a one-half inch diameter combustion chamber and two inter-

(2) Flight Analysis of a Sounding Rocket with Special Reference to Propulsion by Successive Impulses, Hsue-Shen Tsien and Frank J. Malina.

changeable nozzles having a nozzle angle of a six degrees, of 3/16" and 1/8" throat respectively, and constructed of chrome-molybdenum steel. The larger motor had a combustion chamber of 1" diameter and a fixed nozzle of 1/4" orifice and a 9½" degree nozzle angle, constructed of Ludlum Seminole steel treated to give a tensile strength of 130,000 pounds per square inch.

Two spring test-stands were designed to test the motors, one shown in Fig. 2, with two inter-changeable springs have spring constants of 9.44 pounds per inch and 22.4 pounds per inch respectively; and one larger, Fig. 3, of improved design with two variable springs giving 48.67 pounds, and 95.97 pounds respectively to the inch.

Two powders, having the following characteristics, were tested in the motors: (1) Hercules - Laflin and Rand FFG black sporting powder, giving a theoretical velocity of 7,900 feet per second,[(3)] (2) Hercules Bullseye smokeless powder giving a theoretical velocity of 10,600 feet per second.

CALCULATION OF RESULTS

The exhaust velocities were calculated from the deflection of the calibrated spring, the deflection was recorded by means of a movable arm which pushed a rider over a scale. On the basis of the law of conservation of momentum, the following equations can be deduced:

(Let W_1 = weight of moving parts (rocket motor, arm, rider and 1/3 spring) in pounds.

W_2 = weight in pounds of powder and wad.

L = deflection of spring in feet.

V = velocity imparted to moving parts in feet per second.

f = spring constant, pounds per foot.

c = effective exhaust velocity of burnt gases in feet per second.

g = acceleration due to gravity.

(3) From heat energy data supplied by the Hercules Powder Company.

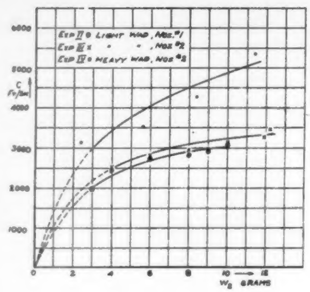


Fig. 4. Variation of the exhaust velocity, c, with weight of powder charge, W_2 and the effects of various wads and nozzles.

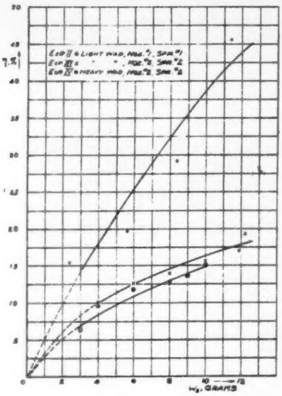


Fig. 5. Variation of the thermal efficiency, with weight of powder charge, W_2 and the effect of various wads and nozzles.

Then, according to the law of conservation of momentum: $\frac{W1V}{g} = \frac{W_2c}{g}$ (1)

And equating the kinetic energy imparted to the moving parts to the work done on the spring we have:

$$\frac{W1V^2}{2g} = \frac{1}{2} f L^2 \quad (2)$$

Substituting the value of v from (1) into (2) we obtain:

$$\frac{W2c^2}{2gW1} = \frac{1}{2} f L^2 \quad (3)$$

Then: $$c = W_1 fg \quad \frac{L}{W_2} \quad (4)$$

The thermal efficiency was calculated by the following method:

If η = thermal efficiency in %

And c_{th} = theoretical exhaust velocity

Then $\eta = \frac{c}{c_{th}} \times 100$

The first series of experiments were made with Hercules Black Powder in in small motor on test stand No. 1. The apparatus was fixed solidly to the ground and the powder ignited by means of a powder fuse.

In Experiment I, averages were obtained with constant powder weight; the average deviation from the mean was found to be 1.4665%. The large nozzle and light spring were used, with the following data for calcula-

tion: $f = 113.28$ pounds per foot; $W_1 = 3.3$ pounds; $c = 109.9\ L/W_2$.

In Experiment II, the same conditions pertained as in Experiment I, with various powder weights. In Experiment III, the small nozzle and heavy spring were used with various powder weights and the following data: $f = 268.81$ pounds per foot; $W_1 = 4.0$ pounds; $c = 185.9\ L/W_2$. In Experiment IV, the same conditions pertained as in Experiment III, with the addition of wadding in the nozzle.

The results of these experiments are shown in Table I and Figs. 4 and 5. The motor was not warm to the hand after the shots. From this data it may be seen that the velocity and efficiency are increased by decreased nozzle throat diameter, by an increased powder weight and by the use of wadding; in other words by the factors which tend to increase the chamber pressure. Actual effective exhaust velocities, in Experiments II, III, and IV, are probably somewhat lower than shown due to the fact that the wadding effect of the fuse was not included in the calculation. This data is, therefore, chiefly valuable in indicating the various trends.

Fig. 6. Model altitude rocket, with small motor attached.

In the second series of experiments different powders and wads were used in the large motor and test stand (Set Up No.2). The powder was packed to an even density with steel blocks and ignited electrically with a wire through the wad.

The average thickness of the wad was: cardboard, 0.100 inches; aluminum, 0.032 inches; leather, 0.200 inches.

Experiment V. Hercules Black Powder, constant weight (2 gms) with different leather wads, $f = 584.04$ lbs/foot, $W_1 = 15.74$ lbs., $c = 543L/W_2$ Notation: R = wad remained in chamber, E = throat eroded, 2, 3, etc. = double and triple wad.

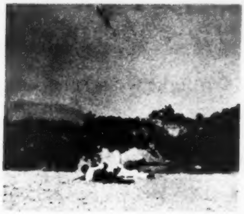


Fig. 7. Model altitude rocket leaving launching tower.

Fig. 8. Model altitude rocket in flight.

(Figs. 6, 7 and 8, Courtesy of Pasadena Star-News and Pose)

No.	Powder weight	Wad.Dia. inches	Wad. wt. pounds	W_2 lbs.	Def. L feet	c ft/sec	%	Notes
1	0.0044	0	0	0	0	0	0	No wad
2	0.0044	1/2 L	0.0016	0.006	0.0241	2180	7.67	-
3	0.0044	3/4 L	0.0031	0.0075	0.0333	2420	9.25	-
4	0.0044	7/8 L	0.0048	0.0092	0.0234	1370	3.02	R
5	0.0044	7/8 L	0.0048	0.0092	0.0254	1500	3.60	R
6	0.022	0	0	0	0.1460	2560	10.50	No wad

Experiment VI Same, with Aluminum wads

7	0.0044	1/2 A	0.0007	0.0051	0.0234	2490	10.00	-
8	0.0044	3/4 A	0.0014	0.0058	0.0216	2020	7.74	R

Experiment VII Same, with Cardboard wads

9	0.0044	1/2 C	0.0005	0.0049	0.216	2280	8.40	-
10	0.0044	3/4 C	0.0012	0.0037	0.200	1900	5.80	R

Experiment VIII Same, with Bullseye Powder Aluminum and Leather Wads

11	0.0044	0	0	0	0	0		No wad
12	0.0044	1/2 L	0.0016	0.0060	0.0725	6550	39.40	-
13	0.0044	1/2 AA	0.0015	0.0059	0.0731	7050	44.40	-

Experiment IX Hercules Bullseye Smokeless Powder at 2 gms. Constant weight, $f = 584.04$ lbs/ft $W_1 = 18.92$ lbs; $C = 594.1\ 1/W_2$ Leather Wads

14	0.0044	1/2 LL	0.0031	0.0075	0.0700	5550	27.41	-
15	0.0044	3/4 L	0.0031	0.0075	0.0675	5440	26.20	-
16	0.0044	3/4 LL	0.0062	0.0108	0.0715	3930	13.75	E*
17	0.0044	1/2 L	0.0016	0.006	0.0483	4760	20.21	-
18	0.0044	1/2 LL	0.0031	0.0075	0.0588	4650	19.28	-

Experiment X Same, with various wad materials

19	0.0044	1/2 CA	0.0013	0.0057	0.0600	6250	34.80	AR
20	0.0044	1/2 CCC	0.0017	0.0061	0.0625	6080	32.98	-
21	0.0044	1/2 CCCA	0.0024	0.0068	0.0625	5460	26.80	-
22	0.0044	3/4 CCC	0.0033	0.0077	0.0416	3190	9.05	CC R

Experiment XI Same, with various powder weights and Leather wads.

23	0.0088	1/2 L	0.0016	0.0104	0.1025	5850	30.40	-
24	0.0088	1/2 LL	0.0031	0.119	0.1240	6180	33.88	E -
25	0.0132	1/2 LL	0.0031	0.0163	0.1960	7150	45.60	E
26	0.0176	1/2 LL	0.0031	0.0207	0.2400	5860	41.0	-

*After No. 16, Experiment IX, a serious throat erosion was noted, enlarging the surface about 20%, and poorer results were obtained. The erosion of the throat increased after shot No. 24, Experiment XI, and considerably more after shot No. 25, Experiment XI. No serious heating was observed; the motor being only slightly warm to the hand after repeated shots. Fouling was considerable with the black powder, but absent with the smokeless.

Due to the problem of erosion the experiments with the large motor were incomplete, and hence do not permit of a detailed analysis at this time. It may be seen, however, that the data tends to substantiate Goddard's claim that high velocities and efficiencies can be obtained by this method, the maximum velocity in No. 25, 7150 feet per second, approaching that obtained by Goddard. In general, the more valid results noted before erosion set in were produced by smaller charges than those used by Goddard in his large motor, consequently the results are expectedly lower.

The authors believe that the importance of the experiments lies in the fact that they show that every factor which tends to increase the chamber pressure, tends to increase the thermal efficiency. In this fact lies the main reason for the high efficiency of the powder rocket. Supporting reasons include the almost complete combustion of the fuel and the short duration of combustion (around 1/5000 second to 1/10,000 second) which allows the processes to take place with minimum heat loss.

As Goddard has shown [(1)] higher efficiencies are obtainable with small grained, fast burning pistol powders which are more completely burned and which give faster rates of pressure rise. [(4)]

From a study of interior ballistics (5) it may be concluded that for black powder, loosely confined, the maximum pressure will not exceed 6,000 pounds per square inch, whereas large charges tightly confined may reach a maximum of 15,000 pounds per square inch. In smokeless powder under the same conditions pressure may vary between 30,000 and 60,000 pounds per square inch. Such pressures should materially increase the

thermal efficiency of the rocket motor by decreasing the dissociation of the combustion gases, and by increasing the ratio p/p' in air.

Conventional smokeless powder is by no means the most powerful explosive available for rocket propulsion; however, before investigating such special mixtures a more complete knowledge is necessary of characteristics of a motor using conventional powders.

At present the authors are working on an erosion-resistant insert of special steel for the large motor; and a satisfactory method of measuring chamber pressures. In addition an automatic injection mechanism is under construction, designed both for ground tests and application to a sounding rocket.

A model altitude rocket, Fig. 6, weighted to about 5 pounds, utililizing the small motor and firing a single charge of black powder has been built for study, and fired from a launching tower to altitudes varying between 30 and 100 feet; Figs.7 and 8 show the rocket in flight. Research into launching morters is also contemplated.

It is hoped that more complete data, in these and allied fields of rocket research, will be available in a few months.

We are greatly indebted to F. J. Malina and H. S. Tsien of the GALCIT Rocket Research project, to Mr. Spade of the Ludlum Steel Company, and to Mr. Henry N. Marsh of the Hercules Powder Company, for their valuable assistance in the research.

(4) Marshall, Explosives, Vol. III

(5) Text Book of Small Arms

THE NEW RECORDING ROCKET RANGE FINDER

by
H. Franklin Pierce and John Shesta

The pressing need for an accurate and dependable instrument to record the altitude and velocity attained by a rocket has resulted in the development of a new Rocket Range Finder by the Experimental Committee. When a shot is to be made two identical instruments are placed at opposite ends of a predetermined base line, with the rocket midway between. Electrical synchronization of the two instruments permits the operator of one to control the time of operation and the recording. The other operator merely has to follow the rocket flight with an eyepiece, which is equipped with cross hairs, mounted in a short tube free to swing in the azimuth plane but not in that of the declination. Movements of this tube are transmitted to a pen which records them on moving graph in terms of degrees.

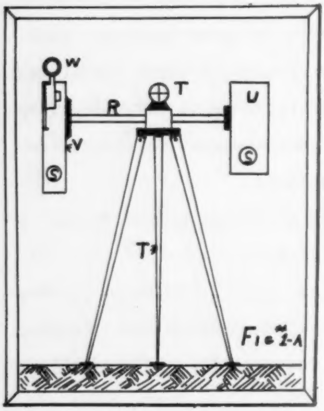
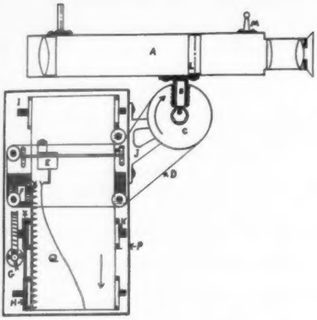


Fig 1-A

The graph is moved over a platen at a constant rate by an electric motor, while the pen travels at right angles to this motion at about .050" per degree of telescope movement. Time is recorded in half-second intervals by a second pen, electromagnetically operated. Lined paper is not necessary, for after the flight a transparent, graduated mask is placed over the tape giving clearly the results from which simple calculations will answer the questions of how high and how fast.

DETAILS OF ROCKET RANGE FINDER

Fig. 1-A shows the instrument and tripod set up as it is used, with pendulum and battery case U mounted on tube R. The eyepiece of the telescope W, is the only part of the device that is movable, the rest being secured firmly to the tripod. The ring and cross hairs shown at T are used to line up one instrument on the other. When this is done the



whole assembly is firmly clamped to the tripod.

Fig. 1 shows the mechanism that records time and change of angle when drum C is revolved by sighting on the rocket during flight through telescope A. The motion is transmitted by steel band D to car E which carries a pen in contact with graph Q. This graph is made by another pen attached to magnet F. The graph is driven from upper to the lower spool by friction roller K, which is rotated by small motor G through pulley X, and friction clutch at H.

The telescope has cross hair elements mounted at L for keeping the rocket in the centre of the field. In case it is lost from view open sights shown at M, are provided to relocate the rocket as quickly as possible.

MEMBERSHIP IN THE AMERICAN ROCKET SOCIETY

Now is the time for those interested in the next major development in the field of Transportation to associate themselves with a group whose efforts are devoted to a study of the principle of jet propulsion. This principle is the only one known to man today which will permit him to free himself from the restraint of air resistance and thus eliminate the last barrier to unlimited speed.

The aircraft industry is constantly striving to add more pounds to pay loads and to add more miles per hour to cruising speeds. Jet propulsion suggests a solution to both problems by boosting take-off thrust and by permitting travel in the rarefied atmosphere of the stratosphere.

Associate yourself now with this fascinating work by joining the AMERICAN ROCKET SOCIETY. There are three types of membership available one of which will appeal to you, whether you are a casually interested youngster under 18 years of age who merely wishes to observe progress in this unexplored field or whether you are a technically trained experimenter who wishes to participate in active research work now in progress for the purpose of establishing basic principles relating to rocket performance.

1. Active Membership: For technically trained experimenters with suitable experience.
2. Associate Membership: For those who wish to aid in rocket research and the publication of results.
3. Junior Membership: For High School students and others under 18 years of age.

Remember -- all members receive ASTRONAUTICS at no extra charge.

Write today to Mr. Max Krauss, Secretary, 50 Church Street, New York City, for further information about the low annual dues and for a membership application blank.

REVIEW OF TECHNICAL ARTICLES

"What Can We Expect of Rockets?"

by Major R. Randolph
Ordnance Reserve, U.S.Army, Kingston, R.I.
"Army Ordnance", Jan.-Feb., 1939, pp.225-7

In this article Major Randolph reviews some of the work of Dr. Goddard and discusses the possibilities and problems of the rocket from a military point of view. The well-known fundamental formula for the relation of acquired rocket velocity to jet velocity in terms of the fuel-dead load ratio is given in slightly modified form, and a table of values calculated for various velocity-ratios to show the increasing efficiency of high jet velocities. He then estimates the temperature range that would be required to produce these jet velocities by equating the kinetic energy of the jet, $c^2/2g$ (per lb. of gases) to the expression for adiabatic expansion in terms of the temperature drop $(R/K-1)(T_1-T_2)$, using values of the gas constant, $R = 53.34$, and the specific heat ratio, $K = 1.4$, for air, (which of course is not valid except for a very rough approximation). He obtains temperature ranges from 4200°F. to 16,750°F. corresponding to jet velocities varying from 6000 to 12,000 ft. per second. He thus illustrates one of the most important problems confronting the experimenter today, that of handling the high temperature of such rapid combustion, which must be done by cooling or other methods.

Problems further discussed in the article are: getting the rocket started in the right direction, by spinning it or having a starting tube; the production of an explosive (dry) having a stable burning rate at pressures of about 1,000 lbs. per sq. in.; tactical advantages and disadvantages in warfare; cost; accuracy of aim, etc. After enumerating very carefully all the problems and difficulties, the article suddenly loses its cautiousness, and claims that equivalents in destructive power of 24-inch shells could be fired. In this connection it is interesting to reproduce the account of this article in the New York Herald-Tribune of January 3, 1939:

"ROCKET BARRAGE SEEN REPLACING HEAVY ARTILLERY
Ordnance Major Says Few Volleys of 24-Inch
Shells Equal Gunfire of Days

Washington, Jan. 2 (AP).- Rockets were suggested by an army officer today as 'gunless artillery' for bombarding cities from great distances in any future war.

American scientists already have overcome some of the practical problems in developing this weapon, Major James R. Randolph, of the Ordnance Reserve wrote in the periodical "Army Ordnance".

Other experts are reported at work in Germany and Russia, he added.

'In the present state of the art,' Randolph said, 'there probably would be no great difficulty in equaling with rockets the performance of the German long-range gun that bombarded Paris from a distance of seventy-five miles.

'But instead of firing shots of moderate caliber at long intervals, a rocket plant could fire the equivalent of twenty-four-inch shells about as fast as desired. Such a job would be no more ahead of present practice than wartime bombing raids were ahead of the airplanes in 1913. And this is only the beginning.'

As one advance, Randolph noted that Dr. Robert H. Goddard, who directed research for the War Department in the World War, has employed liquid oxygen and gasoline instead of smokeless powder in recent rocket experiments in the West.

Other problems, such as aiming the rocket, are not insoluable, he contended.

'The fact that the rocket's firing device would probably cost less than 1 per cent of the cost of an equivalent cannon would enable a much larger number to be fired at once,' Randolph said.

'When a fortified position is to be reduced by cannon, the bombardment often lasts for several days, giving the enemy ample time to bring up reinforcements. With rockets, the whole artillery preparation would probably be shot off at once, or in several volleys.'"

Regardless of whether or not we agree with the views Major Randolph expresses in this article, it is at least a satisfaction to note that some official recognition is at last being made that the rocket has potentialities which deserve for it a more honored place in scientific research than has been its history in the past.

Alfred Africano

ROCKET DEMONSTRATION AT NEW YORK WORLD'S FAIR

In keeping with the New York World's Fair theme "The World of Tomorrow", the Chrysler Corporation presents a most inspiring and effective demonstration entitled the "Rocketport of Tomorrow". Here is enacted in miniature the departure of a rocket ship from New York on its meteoric trip through the stratosphere to London on a schedule of one and one half hours flying time.

Prior to the launching of the rocket ship, a sound film traces the history of transportation down through the ages, beginning with prehistoric man trudging through mud and slime by foot power alone, followed by the inception and development of wind powered sailing vessels, then steam and gasoline powered land vehicles and finally superpowered globe-circling airplanes.

Synchronized with the sound film, red neon lights graphically display on an extensive wall map of the world the progress of man's conquest of time and space in terms of the distance he could cover in three days' travel by various means of transportation. At first he moves only a few miles on foot, then the distance slowly and painfully lengthens through the aid of mechanical power, until at present he can completely circle the globe in three days' time.

Fitting indeed is the climax revealing a stratosphere-piercing rocketship departing on its journey thus closing the last gap in man's age-old battle to conquer space.

As conclusive proof to a skeptical public that such a mode of travel may be realized in the not too distant future, the American Rocket Society has loaned Rocket No.3 to be placed on exhibit in the "Rocketport of Tomorrow" as an actual experimental model built to advance the science of jet propulsion and thus add reality to the demonstration.

Don't miss this inspiring exhibit at the New York World's Fair in the Chrysler Building, Transportation area. Admission is free and the performance will take only about 12 minutes of your time.